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Searching and Sorting Prioritization of Sets within Dodecagon of Company Departments using: Analytic Hierarchy Process (AHP) Analysis

Hussain Al-Salamin[1*] Tembe Elias[2]

1. University Campus , King Fiasal University, Saudi Arabia, PO box 35886 , Hofuf 31982
2. School of Business, King Fiasal University, Saudi Arabia, PO box 1760, Hofuf 31982

Abstract
Dodecagram is a geometric mathematical polygon with twelve sets (sides, arrays) and twelve angles which are polymorphic, homomorphic, and orthogonal. The paper presents twelve sets (arrays of arrays, departments) which represent typical departments of enterprise. The main purpose of the research is search and sort the sets (arrays) using one of the most popular operational research (OR) /decision science(DS)/management science (MS) tool known as Analytic Hierarchy Process (AHP) Analysis. The connection within the twelve sets are represented using configuration of abelian graph and complete graphs. The characteristic of abelian graph and complete graphs is that the connection (collection) is without sub optimization with each other (Hussain and Tembe, 2014). It is attractive and interesting to use searching and sorting algorithms because searching and sorting are the two most widely and thoroughly studied, researched, and applied analytic and stochastic mathematical computation topics across many disciplines. It further noteworthy to point out that there are several sorting and searching algorithms. One of the algorithm used in the paper is prioritization using visual programming language with AHP . Sorting and searching can be used specially for interface elements for listed or linked lists(array of arrays). All the set are interlocked via supply chain. The further purpose of this paper is bring analogy that Dodecagram sets are interconnected with supply chain(SC).
Keywords: AHP, Dodecagon, Abelian , Supply Chain, Decision Science, Management Science, Analytics, sub optimization.

1. Introduction

There are manifold of definitions of departments that scholars and writers were suggested and offered. Department can be defined as " a distinct part of anything arranged in divisions; a division of a complex whole or organized system " .Also, it can be defined as " A distinct, usually specialized division of a large organization, especially:
a. A principal administrative division of a government: the department of public works.
b. A division of a business specializing in a particular product or service: the personnel department.
c. A division of a school or college dealing with a particular field of knowledge: the physics department " . Finally, Department may refer to:" departmentalization, division of a larger organization into parts with specific responsibility. "

There are several departments in any organization which these departments are working together in order to success and make a surplus profitability for their organizations. There are no exact standard which organization should follow when they set their departments, but there are common departments in any organization. Moreover, departments are differ between sizes and types of organizations. Kotler Keller in his book " Marketing Management" mentioned that company departments are : "R&D, Purchasing, Manufacturing, Marketing, Sales, Logistics, Accounting, Finance, and Public Relations". Business departments are : " Accounting, Human Resources (Personnel), Marketing and Sales, Operations, Procurement, Research and Development, Information Technology, Administration, and Logistics". As per Heizer and Render that the essential function or department of any organization are : Marketing, Production/operations, and Finance/accounting .

Hence , researchers try to develop a holistic conceptual framework that integrate and merge all department that may find in any organization despite of sizes and types of that organizations. These department as per researchers view are :
A. Research and Development (R &D): Make, Create, and Innovate .
B. Sourcing \ Procurement \ Purchasing: It is clearly procurement.
C. Production \ Manufacturing \ Inventory : Creation, Processing, and Transformation.
D. Demand (Marketing \ Sales \ services) : It is clearly Marketing.
E. Logistics : Engineering \ Design \ Distribution \ Maintenance and Reliability.
F. Accounting: Money transactions.
G. Finance (Pricing): Money collection and payments of bills.
H. Human Resource (HR) (Public Relation): Customer Relationship Management (CRM)

and Internal Customer Management (ICM).
I. Information Technology (I.T): Just in Time , Timeliness.
J. Ethics : Morale , Right or Wrong.
K. Sustainability : " Meeting humanities needs without harming future generation".
L. Quality Control \ Quality Assurance (QC \ QC) : Act of god or phenonmology.
This paper used Analytic Hierarchy Process (AHP) Analysis as a mathematical tool to see which department is the most paramount and imperative important among several department in any organization.

2. Statement of Problem

The potential benefits of knowing which department is the most important within an enterprise have not been investigated using AHP operational research (OR) technique within the application of supply chain are not related by researchers and scholars.

3. Purpose of Study

The purpose of this research is to sort (prioritize) which department is the most important in any enterprise and to put the greatest efforts in these important departments.

4. Conceptual Framework

Departments in any organizations are interrelated and work together to satisfy customers and stakeholders . Researchers modify a conceptual framework that explain this interrelated tasks and processes among each department. Researchers modified original dodecagon with adding capital letters to explain twelve suggested departments whixh bring analogy that Dodecagram sets are interconnected with supply chain(SC).

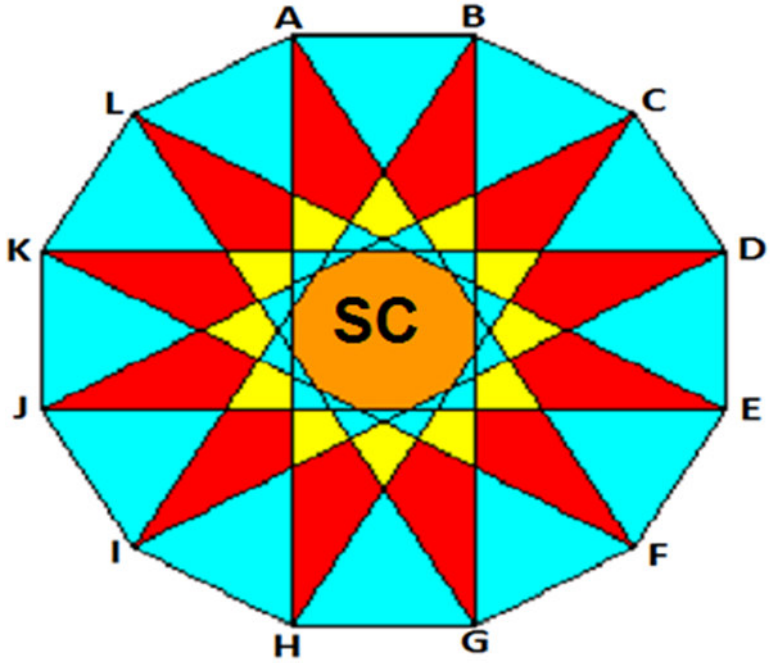

Figure 1. Modified Conceptual framework of a Dodecagon
Source: : Constructing a Dodecagon from a Circle, in Google SketchUp

5. Methodology

5.1 The Analytical Hierarchy Process – AHP

"AHP is one of most popular decision analysis the multiple criteria for problem solving and decision-making method and process that was originally developed by Thomas L. Saaty (1977). AHP provides measures of judgment consistency, derives priorities among criteria and alternatives, and simplifies preference ratings among decision criteria using pair wise comparisons. The basic procedure is as follows:

1. Develop the ratings for each decision alternative for each criterion by:

- developing a pair wise comparison matrix for each criterion
- normalizing the resulting matrix
- averaging the values in each row to get the corresponding rating
- calculating and checking the consistency ratio

2. Develop the weights for the criteria by:
• developing a pair wise comparison matrix for each criterion
• normalizing the resulting matrix
• averaging the values in each row to get the corresponding rating
• calculating and checking the consistency ratio
3. Calculate the weighted average rating for each decision alternative. Choose the one with the highest score. "

5.2 AHP Analysis Steps :

- *The first step in the AHP procedure is to make pair wise comparisons between each criterion.*

Table 1. The example scale for comparison (Saaty& Vargas, 1991).

Scale	Degree of preference
1	Equal importance
3	Moderate importance of one factor over another
5	Strong or essential importance
7	Very strong importance
9	Extreme importance
2,4,6,8	Values for inverse comparison

Results of the comparison (for each factors pair) were described in term of integer values from 1 (equal value) to 9 (extreme different) where higher number means the chosen factor is considered more important in greater degree than other factor being compared with."

Table 2. The example scale for importance (Saaty& Vargas, 1991).

Factor	Factor weighting score			Factor
	More importance than	Equal	Less importance than	
C1	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	**C2**
C2	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	**C3**
C3	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	**C4**
C4	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	**C5**
C5	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	**C6**
C6	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	**C7**
C7	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	**C8**
C8	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	**C9**
C9	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	**C10**
C10	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	**C11**
C11	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	**C12**
C12	.....			

where :
A. Research and Development (R &D): Make, Create, and Innovate . (C1)
B. Sourcing \ Procurement \ Purchasing: It is clearly procurement. (C2)
C. Production \ Manufacturing \ Inventory : Creation, Processing, and Transformation.(C3)
D. Demand (Marketing \ Sales \ services) : It is clearly Marketing.(C4)
E. Logistics : Engineering \ Design \ Distribution \ Maintenance and Reliability.(C5)
F. Accounting: Money transactions. (C6)
G. Finance (Pricing): Money collection and payments of bills. (C7)
H. Human Resource (HR) (Public Relation): Customer Relationship Management(CRM) and Internal Customer Management (ICM). (C8)
I. Information Technology (I.T): Just in Time , Timeliness. .(C9)
J. Ethics : Morale , Right or Wrong. (C10)
K. Sustainability : " Meeting humanities needs without harming future generation". (C11)
L. Quality Control \ Quality Assurance (QC \ QC) : Act of god or phenonmology. (C12)

Step 1: Pair wise comparison

Table 3. Pair wise comparison matrix which holds the preference values

#	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Factor	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
2	C1	1	7	5	1	3	5	5	1	1	1	2	1
3	C2	0.14	1	1	3	1	1	1	6	4	1	2	1
4	C3	0.2	1	1	1	5	3	3	1	1	1	2	1
5	C4	1	0.33	1	1	9	7	7	1	1	1	2	1
6	C5	0.33	1	0.2	0.11	1	4	4	8	8	1	1	1
7	C6	0.2	1	0.33	0.14	0.25	1	1	6	6	1	1	1
8	C7	0.2	1	0.33	0.14	0.25	1	1	8	8	1	1	1
9	C8	1	0.17	1	1	0.13	0.17	0.17	1	1	1	1	1
10	C9	1	0.25	1	1	0.13	0.17	0.13	1	1	1	1	1
11	C10	0.5	1	1	1	1	1	1	1	1	1	1	1
12	C11	0.5	0.5	0.5	0.5	1	1	1	1	1	1	1	1
13	C12	1	1	1	1	1	1	1	1	1	1	1	1
Total		7.07	15.25	13.36	10.89	22.76	25.34	25.3	*36*	34	12	16	12

Step 2: Normalization

This step is to normalize the matrix by totaling the numbers in each column.
Each entry in the column is then divided by the column sum to yield its normalized score.
The sum of each column is 1.

Table 4. Normalization

#	A	B	C	D	E	F	G	H	I	J	K	L	M	Total	Average
1	Factor	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12		
2	C1	0.14	0.46	0.37	0.09	0.13	0.2	0.2	0.2	0.03	0.03	0.13	0.08	2.06	*0.17*
3	C2	0.02	0.07	0.07	0.28	0.04	0.04	0.04	0.17	0.12	0.08	0.13	0.08	1.14	0.10
4	C3	0.03	0.07	0.07	0.09	0.22	0.12	0.12	0.03	0.03	0.08	0.13	0.08	1.07	0.09
5	C4	0.14	0.02	0.07	0.09	0.40	0.28	0.28	0.03	0.03	0.08	0.13	0.08	1.63	0.14
6	C5	0.05	0.07	0.01	0.01	0.04	0.16	0.16	0.22	0.24	0.08	0.06	0.08	1.18	0.10
7	C6	0.03	0.07	0.02	0.01	0.01	0.04	0.04	0.17	0.18	0.08	0.06	0.08	0.79	0.07
8	C7	0.03	0.07	0.02	0.01	0.01	0.04	0.04	0.22	0.24	0.08	0.06	0.08	0.9	0.08
9	C8	0.14	0.01	0.07	0.01	0.01	0.01	0.01	0.03	0.03	0.08	0.06	0.08	0.54	0.05
10	C9	0.14	0.2	0.07	0.01	0.01	0.01	0.01	0.03	0.03	0.08	0.06	0.08	0.73	0.06
11	C10	0.07	0.07	0.07	0.01	0.04	0.04	0.04	0.03	0.03	0.08	0.06	0.08	0.62	0.05
12	C11	0.07	0.03	0.04	0.05	0.04	0.04	0.04	0.03	0.03	0.08	0.06	0.08	0.59	0.05
13	C12	0.14	0.07	0.07	0.01	0.04	0.04	0.04	0.03	0.03	0.08	0.06	0.08	0.69	0.06

Step 3: Consistency analysis

Now, calculate the consistency ratio and check its value.
The purpose for doing this is to make sure that the original preference ratings were consistent.

There are 3 steps to arrive at the consistency ratio:

1.Calculate the consistency measure.
2.Calculate the consistency index (CI).
3.Calculate the consistency ratio (CI/RI where RI is a random index).
CI =(λ *max* – *n*)/ (n- 1)
CR = CI / RI
To calculate the consistency measure, we can take advantage of Excel's
Matrix multiplication function **=MMULT ()**.

Approximation of the Consistency Index(CI)

1. Multiply each column of the pair wise comparison matrix by the corresponding weight.
2. Divide of sum of the row entries by the corresponding weight.
3. Compute the average of the values from step 2, denote it by λ *max* .
4. The approximate CI =(λ *max* – *n*)/ (n- 1)

Consistency Index (CI)

Reflects the consistency of one's judgment CI =(λ *max* – *n*)/ (n- 1)

Random Index (RI)

Table 5. The CI of a randomly-generated pair wise comparison matrix

n	1	2	3	4	5	6	7	8
RI	0	0	0.52	0.89	1.12	1.26	1.36	1.41
n	9	10	11	12	13	14	15	
RI	1.46	1.49	1.52	1.54	1.56	1.58	1.59	

Consistency Ratio (CR)

CR = CI / RI

Table 6. Consistency ratio

#	A	B	C	D	E	F	G	H	I	J	K	L	M	Total	Avg.	Consistency Measure
1	Factor	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12			
2	C1	0.14	0.46	0.37	0.09	0..13	0.2	0.2	0.2	0.03	0.03	0.13	0.08	2.06	0.17	1.03
3	C2	0.02	0.07	0.07	0.28	0.04	0.04	0.04	0.17	0.12	0.08	0.13	0.08	1.14	0.10	0.99
4	C3	0.03	0.07	0.07	0.09	0.22	0.12	0.12	0.03	0.03	0.08	0.13	0.08	1.07	0.09	0.98
5	C4	0.14	0.02	0.07	0.09	0.40	0.28	0.28	0.03	0.03	0.08	0.13	0.08	1.63	0.14	1.04
6	C5	0.05	0.07	0.01	0.01	0.04	0.16	0.16	0.22	0.24	0.08	0.06	0.08	1.18	0.10	0.81
7	C6	0.03	0.07	0.02	0.01	0.01	0.04	0.04	0.17	0.18	0.08	0.06	0.08	0.79	0.07	0.79
8	C7	0.03	0.07	0.02	0.01	0.01	0.04	0.04	0.22	0.24	0.08	0.06	0.08	0.9	0.08	0.78
9	C8	0.14	0.01	0.07	0.01	0.01	0.01	0.01	0.03	0.03	0.08	0.06	0.08	0.54	0.05	1.11
10	C9	0.14	0.2	0.07	0.01	0.01	0.01	0.01	0.03	0.03	0.08	0.06	0.08	0.73	0.06	1.12
11	C10	0.07	0.07	0.07	0.01	0.04	0.04	0.04	0.03	0.03	0.08	0.06	0.08	0.62	0.05	0.98
12	C11	0.07	0.03	0.04	0.05	0.04	0.04	0.04	0.03	0.03	0.08	0.06	0.08	0.59	0.05	1.01
13	C12	0.14	0.07	0.07	0.01	0.04	0.04	0.04	0.03	0.03	0.08	0.06	0.08	0.69	0.06	1.09
Total		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			CI =		- 1.08
														RI =		1.54
														CR =		- 0.70

6. Discussion

In practice, a CR of 0.1 or below is considered acceptable.

• Any higher value at any level indicates that the judgments warrant re-examination.

So,

CR = -0.7 is acceptable since it is below 0.1

7. Conclusion

After implementing AHP analysis technique and results from tables above, researchers found that priorities are as this order:

Table 7. Consistency ratio

Total	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
	7.07	15.25	13.36	10.89	22.76	25.34	25.3	36	34	12	16	12

H. Human Resource (HR) (Public Relation): Customer Relationship Management(CRM) and Internal Customer Management (ICM). (C8)

I. Information Technology (I.T): Just in Time , Timeliness.(C9)

F. Accounting: Money transactions. (C6)

G. Finance (Pricing): Money collection and payments of bills. (C7)

E. Logistics : Engineering \ Design \ Distribution \ Maintenance and Reliability.(C5)

K. Sustainability : " Meeting humanities needs without harming future generation". (C11)

B. Sourcing \ Procurement \ Purchasing: It is clearly procurement. (C2)

C. Production \ Manufacturing \ Inventory : Creation, Processing, and Transformation.(C3)

J. Ethics : Morale , Right or Wrong. (C10)

L. Quality Control \ Quality Assurance (QC \ QC) : Act of god or phenonmology. (C12)

D. Demand (Marketing \ Sales \ services) : It is clearly Marketing.(C4)

A. Research and Development (R &D): Make, Create, and Innovate . (C1)

Founding results were clearly showing that human resource is most important department which each organizations should increase their efforts on it with Customer Relationship Management(CRM) and Internal

Customer Management (ICM) . The second important department is the information technology and the trend today is to share every transactions, information and processes via technologies with just in time concept . Accounting and finance are the third and fourth important department respectively. Logistics and sustainability comes to be the most important department in next future. Research and development comes at the end of prioritization of department which make a big question about ignoring the importance of this department. Finally, the prioritization may differ if put in mind other criteria but other scholars or researchers.

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First A. Author: Hussain Al-Salamin is completing MBA from King Fiasal University (KFU) (2014) with highest performance in his class. He completed B.A. in Electrical Engineering from King Fahad University of Petroleum and Minerals (2007) . Eng. Hussain joined KFU in 2010 as project engineer at new construction of University Campus. His professional interest is researching include : Operation +Management, Supply-Chain Management, Marketing Management, E-Business, and Environment and Recycle.

Second A. Author :Dr. Elias Ogutu Azariah Tembe received his doctorate the University Of Arizona Tucson, USA. He has taught Computer Science, Computer Information Systems, Commerce, and Business Management at various institutions of higher learning. His areas of interest are Artificial Intelligence (AI), Supply Chain, Operational Research (OR), Production and Operations/Service Management, Ethics and Sustainability and International Business. He has taught at Kenyatta University in Kenya, University of Nairobi in Kenya, Mary Holmes College in Mississippi, Norwich University, Vermont, USA, and Wiley College in Marshall, Texas, USA, University of Dubuque in Dubuque, Iowa, USA and King Faisal University, Kingdom of Saudi Arabia. He has also been adjunct professor at Edgewood College, Madison, Wisconsin, USA, and Grandview University in Iowa, USA. He was visiting research scholar at University of Luton, England in Computer Science. He attended the University of Toledo, Toledo USA as Post Doctorate Research Scholar in Supply Chain in supply chain.

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